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REPORT OF THE

TENTH MEETING OF THE WORKING PARTY ON RICE PRODUCTION AND PROTECTION OF THE INTERNATIONAL RICE COMMISSION

Held at Manila, Philippines
March 1964

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Reports of the International Rice Commission's Working Party on Rice Breeding have been issued as follows:

First Meeting of the Working Party on Rice Breeding, Rangoon, Burma, February 1950.
Second Meeting of the Working Party on Rice Breeding, Bogor, Indonesia, April 1951.
Third Meeting of the Working Party on Rice Breeding, Bandung, Indonesia, May 1952.
Fourth Meeting of the Working Party on Rice Breeding, Bangkok, Thailand, September 1953.
Fifth Meeting of the Working Party on Rice Breeding, Tokyo, Japan, October 1954.
Sixth Meeting of the Working Party on Rice Breeding, Penang, Malaya, December 1955 (1955/25).
Joint Report of the Seventh Meeting of the Working Party on Rice Breeding; the Sixth Meeting of the Working Party on Fertilizers; and the First Meeting of the *ad hoc* Working Group on Soil-Water-Plant Relationships, Vercelli, Italy, September 1957 (1957/18).
Eighth Meeting of the Working Party on Rice Production and Protection of the International Rice Commission, Peradeniya, Ceylon, 1959 (PL/1960/5).
Ninth Meeting of the Working Party on Rice Production and Protection of the International Rice Commission, New Delhi, India, December 1961 (PL/1962/3).

Meeting Report
No. PL/1964/3

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Manila, The Philippines

3-10 March 1964

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, Italy 1964

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Report of the Joint Meeting with the Working Party on Rice Soils, Water and Fertilizer Practices and the Working Party on The Agricultural Engineering Aspects of Rice Production, Storage and Processing.

INTRODUCTION

Meetings of the Three Working Parties of the International Rice Commission were convened by the Food and Agriculture Organization of the United Nations and were held at the kind invitation of the Government of the Republic of the Philippines in Manila from 3 to 14 March 1964 as follows:-

3-10 March 1964	10th Meeting of the Working Party on Rice Production and Protection
3-10 March 1964	9th Meeting of the Working Party on Rice Soils, Water and Fertilizer Practices
7-14 March 1964	3rd Meeting of the Working Party on Agricultural Engineering Aspect of Rice Production, Storage and Processing.

The joint opening session was attended by 41 delegates from 12 member countries, one delegate of the International Atomic Energy Agency, 4 observer from non-member countries and 8 from the International Rice Research Institute.

The meetings were opened by Director Eugenio E. Cruz, Chairman of the FAO/IRC Committee and Director of the Bureau of Plant Industry in Manila, who welcomed the participants and extended his best wishes for the success of the meetings. He was followed by Mr. Soesilo H. Prakoso, Deputy Regional Representative of the FAO for Asia and the Far East, who thanked the Government of the Republic of the Philippines on behalf of the Director-General for their excellent arrangements and hospitality. He drew the special attention of delegates to the agenda item relating to the proposal to declare 1966 as an International Rice Year and invited discussions and suggestions which would be valuable to the Director-General in the preparation of his report to the FAO Council.

His Excellency Jose Y. Feliciano, Secretary of Agriculture and Natural Resources, underlined the need to increase the world's food supplies through co-ordinated action to meet the challenge of the increasing world population. In the Philippines, national production of rice, which does not meet the domestic requirements, could be increased materially through the application of technical knowledge already available if social and economic bottlenecks could be removed and the farmers encouraged to adopt recommended practices.

As a number of subjects were of interest to all three Working Parties, a day was devoted to a Joint Meeting. The report of this Meeting is appended.

At the closing of the Meetings, Mr. Prakoso in the name of the Director-General of FAO, and Mr. Angladette on behalf of his government and in the name of all participants, expressed their gratitude to the Government of the Philippines for serving as host to the three Working Parties and for the excellent facilities it provided for the success of the Meetings. Appreciation was also expressed for the opportunity to visit the Bureaux of the Ministry of Agriculture, the College of Agriculture and the International Rice Research Institute at Los Banos.

PARTICIPATION IN THE MEETING

MEMBER COUNTRIES

Australia
E.C.B. Langfield
Plant Breeder
Coastal Plains Research Station
C.S.I.R.O.
Darwin

Ceylon
D.V.W. Abeygunawardena
Plant Pathologist
Department of Agriculture
Peradeniya

E.H.W. Jayasekara
Botanist
Department of Agriculture
Peradeniya

France
A. Angladette
Institut des Recherches Agronomiques Tropicales
et des Cultures Vivrières
110 rue de l'Université
Paris 7e

René Marie
Spécialiste de l'Amélioration du Riz
Station d'Amélioration des Plantes
Centre de Recherches Agronomiques du Midi
E.N.S.A.
Place Viala
Montpellier

India
S.Y. Padmanabhan
Mycologist, Director
Central Rice Research Institute
Cuttack 6
Orissa

Parashuram Yadavrao Shendge
Rice Specialist
Department of Agriculture
Maharashtra State
Karjat District
Kolaba

Iran
Ali Mojtahedi
Associate Director of Seed and Plant Improvement Institute
26 Nojoumi St.
Roosevelt Avenue
Teheran

Japan

Hidetsugu Ishikura
Chief, Plant Protection Section
Ministry of Agriculture and Forestry
Kasumigaseki
Chiyoda-ku
Tokyo

Noboru Yamada
Chief, Section of Plant Physiology
Department of Physiology and Genetics
National Institute of Agricultural Sciences
Konosu, Saitama

Philippines

Eugenio E. Cruz
Director
Bureau of Plant Industry
Manila

Roman S. Abalos
Senior Entomologist
Maligaya Experiment Station
Munoz, Nueva Ecija

Apolinario D. Benitez
Supervising Agronomist (Rice and Corn)
38 Minnesota Avenue
Cubao, Quezon City

Esteban C. Cada
Supervising Agronomist (Plant Breeder)
Maligaya Experiment Station
Munoz, Nueva Ecija

Feliciano B. Calora
Chairman, Department of Entomology
University of the Philippines
College of Agriculture
Laguna

Francisco B. Claridad
Plant Breeder
Head, Department of Plant Breeding
Araneta University
Victoneta Park, Rizal

Hipolito A. Custodio
Senior Entomologist
Head, Toxicology and Agricultural Chemicals Unit
Pest and Disease Control Division
Bureau of Plant Industry
Manila

Philippines (Continued)

Felix D. Enrile
Supervising Agronomist
Production Division
Bureau of Plant Industry
Manila

Pedro B. Escuro
Research Associate Professor in Plant Breeding
College of Agriculture
University of the Philippines
Laguna

Presciliano D. Evangelista
Agricultural Economist
Acting Chief, Planning and Programming Division
Rice and Corn Board
Port Area
Manila

Tranquilino G. Fajardo
Plant Pathologist
Bureau of Plant Industry
Manila

Daniel F. Francisco
Agricultural Productivity Commission
Diliman, Quezon City

Marceliano A. Ganay
Agronomist
Chief, Technical Plans and Schedules Division
Department of Agriculture and Natural Resources
Diliman, Quezon City

Alfredo Hernaez
Agronomist
Chief, Production Division
Bureau of Plant Industry
Manila

Silvisio C. Hernandez
Bureau of Soils
Manila

Emiliano C. Hipol
Irrigation Engineer
Commission on Agricultural Productivity
Diliman, Quezon City

Teodoro A. Irabagon
Central Luzon Agricultural College
Luzon

Philippines
(Continued)

José L. Morales
Chief, Pest and Disease Control Division
Bureau of Plant Industry
Manila

Severo B. Mulimban
Superintendent
Maligaya Experiment Station
Munoz, Nueva Ecija

Faustino T. Orillo
Plant Pathologist
Director of Research, College of Agriculture
University of the Philippines
Laguna

Consorcio L. Padolina
Bureau of Plant Industry
Manila

Ambrosio H. Ramos
Bureau of Plant Industry
Manila

Pakistan

S.M.H. Zaman
Rice Breeder
Agriculture Research Institute
Dacca-5, East Pakistan

Thailand

Bhakdi Lusanandana
Agronomist, Chief, Technical Division
Rice Department
Ministry of Agriculture
Bangkok

Sermsak Awakul
Agronomist
Chief, Breeding Section, Rice Department
Ministry of Agriculture
Bangkok

Tanongchit Wongsiri
Entomologist
Technical Division, Rice Department
Ministry of Agriculture
Bangkok

United Arab Republic

Tewfik Abdel Hak
Plant Pathologist
Director, Cereal Diseases Research Section
Ministry of Agriculture
Giza-Orman

Ismail Sorry Ahmed
Cereal Diseases Research Section
Ministry of Agriculture
Giza-Orman

United States of America

C. Roy Adair
Leader, Rice Investigation
Cereal Crops Research Branch
Crops Research Division
Agricultural Research Service
U.S. Department of Agriculture
Beltsville, Maryland

Charles A. Breitenbach
Plant Breeder, USOM/Thailand
c/o American Embassy
Bangkok, Thailand

Vietnam

Doan Minh Quan
Agronomist
Chief, Rice Service
1 Phan Thanh Gian Street
Saigon

OBSERVERS

Hong Kong

Pak Ling Siak
Agronomist
Agriculture and Forestry Department
Kowloon

Madagascar

Velly
Institut de Recherches Agronomiques de Madagascar
Madagascar

Sierra Leone

H.D. Jordan
Botanist
Director, West African Rice Research Station
Rokupr

J.W.O. Jeffery
Soil Scientist
West African Rice Research Station
Rokupr

International Rice Research Institute
(University of the Philippines, College of Agriculture, Laguna)

Robert F. Chandler, Jr., Director

Henry M. Beachell, Plant Breeder

Te-Tzu Chang, Geneticist

Tosi Take Iida, Plant Pathologist (Virus diseases)

Peter R. Jennings, Plant Breeder

John L. Nickel, Visiting Scientist (Entomologist)

Shu-Huang Ou, Plant Pathologist

Mano Dutta Pathak, Entomologist

FAO Staff, Headquarters, Rome

Rainer W. Schickele
Director, Land and Water Development Divisio

C. Logothetis
Entomologist (Joint Technical Secretary)
Plant Production and Protection Division

N.N. Bentley
Technical Officer
Office of the Assistant Director-General
Technical Department

FAO Staff (Regional Office, Bangkok)

Soesilo H. Prakoso
Deputy Regional Representative of the
Director-General for Asia and the Far East

N. Parthasarathy
Executive-Secretary of the International Rice
Commission (Joint Technical Secretary)
and Regional Rice Improvement Specialist

A. Johnston
Regional Agricultural Officer (Plant Protection)

Officers of the Meeting

The Meeting elected Dr. Eugenio E. Cruz as Chairman, and Dr. Roy C. Adair and Mr. Doan Minh Quan as Vice-Chairmen. Messrs. Esteban C. Cada, Hipolito A. Custodio, H.D. Jordan, Faustino T. Orillo, and S.Y. Padmanabhan were designated as members of the Drafting Committee. Drs. C. Logothetis and N. Parthasarathy served as Joint Technical Secretaries.

SUMMARY OF DISCUSSIONS

Report on the Progress of Breeding and Testing Varieties with Wide Adaptability

In pursuance of the recommendations of the 8th and 9th meetings of the Working Party, a list of promising varieties, which had already shown adaptation to different environmental conditions in the countries of their origin, was compiled and exchange of seeds of those varieties was arranged among the participating countries. A plan for conducting trials in a uniform manner under more or less similar fertility conditions was supplied.

Reports on those trials were received from Australia, France, India, Malaysia, Pakistan, Philippines, Sierra Leone, Netherlands (Surinam), Taiwan, Thailand, U.K. (Hong Kong), U.S.A. and Vietnam.

Australia. Four japonica x indica hybrids of F_2 sent from Cuttack were tested in several locations in N. Australia, where they were found to be widely adapted, to have grain yields at least equal to the standard varieties and to possess better agronomic characteristics. One of these has been released for commercial cultivation under the name "Sirona".

In New South Wales, the long grain variety Blue Bonnet 50 when compared to the prevalent short grain Caloro type of japonica varieties yielded not more than about 50% of the yields of the japonicas. It did not respond to soil fertility and could be grown successfully only on soils of low fertility. However, production of this long grain variety will probably continue because of the high price obtained for it.

France. Sixty-six varieties on the FAO list were tested in 1962 in the experimental field of the Plant Breeding Station at Montpellier. Of those, the varieties received from tropical areas and from U.A.R., Korea, Taiwan and the U.S.A. either did not head at all or matured late. The four Italian varieties and the variety CH 1039 produced a satisfactory crop but of lesser commercial value because of a large number of grains not reaching maturity. Nevertheless, the Italian variety V 640 and the variety CH 1039 are of interest as genetic stock.

India. Co-operative trials were carried out during 1962 and 1963 to select varieties of wide adaptability. Those included 12 early maturing and 28 each of medium and late maturing varieties and were recommended for cultivation in the different rice growing states of India.

The results showed that the early varieties TKM 6 and CO 29 from Madras, PTB 10 from Kerala, N.C. 1626 from West Bengal, T 21 and China 4 from Uttar Pradesh, appeared to be of wide adaptability.

Of the medium maturing varieties the performance of MTU 16 from Andhra Pradesh, GEB 24 from Madras and T 141 from Orissa appeared to be of note, while those of the late maturing S 1092 from Mysore, Patnai 23, Bhasamanic, and Latisail from West Bengal, have done well in the Madras (South), Assam (North East), and Maharashtra (West) rice growing regions.

Malaysia. During 1961-62, 18 varieties from Madagascar, Burma, Sierra Leone, Surinam, Philippines, Thailand and Ceylon were tested. The highest average weight of panicles per hill was 45-49 grams, produced by D 17/88 from Burma, Raminad Str. 3 from the Philippines and Leuan Rahaeng from Thailand. As a result of trials of indica-japonica hybrids, a new variety Malinja (D.C.4) has been released for commercial cultivation during the second crop season. This will replace the present variety Bir-mo-fen (Pebifun), which is not popular with the farmers.

Pakistan (West). Of the 29 varieties received and tried in single row plots during the 1963 rice season at Kalasha-Kaku, 18 varieties from Burma, Taiwan, Italy, Philippines, and India failed to germinate. The yield data based on 10 plants each of the other varieties indicated that none of them was better than the local variety 349 Jhona, though Nato, Blue-Bonnet, Fortuna, Norin 1 and Taichung 65 proved to be stiff stemmed.

Pakistan (East). Most of the FAO co-operative trial varieties failed to mature, but a few varieties from Formosa, Japan, Egypt and Porto Rico performed very well in the season November to April. The yield was approximately 6000 lbs per acre but the farmers are very reluctant to grow these due to their unsatisfactory cooking quality.

About 30 strains of the "indica-japonica" hybridisation programme are in different stages of yield trials. Varieties like Nizersail (DA-25), which is the same as GEB 24, and Latisail (DA-17), have wide adaptability and can be grown as transplanted aman crop all over East Pakistan. The new varieties DA-29 and DA-31 are becoming very popular, especially the latter one which can be transplanted in mid-July and harvested by the first week of November, thus allowing the farmer to cultivate winter crops.

Philippines. The trials were conducted at the UP College of Agriculture and the Maligaya Experiment Station, though some of the varieties were not tested in both places. Out of 40 varieties tested at the College of Agriculture in the preliminary trials in the 1961 wet season, seven indica varieties were tested in 1962, and four of these excelled in one or more desirable characters and were selected for further trials: D 52/37 for high yield, A 29-20 for short stiff straw and heavy panicle, Latisail for high tiller number and Radin-Kling for more grains per panicle. These and BPI-76 (local) which are resistant to lodging were inter-crossed in the 1963 season.

In the 1962 and 1963 trials at Maligaya Experiment Station of the Bureau of Plant Industry, six out of 17 varieties tested performed well when compared with local checks: C 15-10, A 29-20, B 43-11 and D 17 from Burma, Radin-Kling from Malaysia and Srivimankoti from Surinam. These will be included in the regional tests.

At the UP College of Agriculture, earlier work in screening nearly 2300 varieties obtained from U.S.A. resulted in the selection of six japonica varieties which out-yielded the check, Milfor 6(2); viz Tainan Iky No. 486, Tako No. 24, Tainan No. 2, Taichu Mochi No. 67, Tainan Iku No. 520 and Shinchukuiku No. 74 all from Taiwan. These are to be used in future breeding programmes.

Sierra Leone. Results from two years' observations indicated the usefulness of the following varieties in future breeding programmes though their yields were somewhat below local standards: Basmathi 370, Patnai 23, and Latisail in the medium maturing group; and A 29/20, C 15-10, GEB 24, Peta, D 52/37 and Raminad Str. 3 in the late maturing group.

The varieties which have out-yielded or approached the local standards, and which are included in future trials are (1) Radin-Kling for lowland and (2) Azucena for upland varieties. A second group of 18 varieties tested for the last two seasons have indicated the following varieties as useful in breeding: MTU 9, Srivimankoti, Dima, SML 242, Panbira, Bangawan, Bir-me-fan, Chianan, 8, Taichung Native 1 and Kauoshiung 68.

Varieties which are continued for further yield trials are (1) Loumuo Nahug 111 as a floating rice and (2) (Dissi Hatif) DH 2, a short maturing (135 days) non-sensitive crop for the dry season.

Netherlands (Surinam). Most of the 18 varieties tested were highly sensitive and only a few, FB 76 (BPI 76), Kamakyi (D 17/88), Taichung Native 1, Bir-me-fan and ASD 5 justified further testing.

U.K. (Hong Kong). Eleven varieties from India, Pakistan, Philippines, Taiwan and U.S.A were tried for four cropping seasons during 1961-63. During the first trials in the second crop season, two varieties, Panbira and Patnai-23 from Pakistan failed to flower and Tkm. 6, Bir-me-fan, Taichung 65, Nato and Blue-Bonnet were found susceptible to blast. The varieties Taichung Native 1 and Chianan 8 from Taiwan gave promising results. Azucena from the Philippines gave the highest yield but was found susceptible to blast. None of the blast-susceptible varieties could be recommended due to the severity of this disease in the territory.

Taiwan. About 20 varieties sent by FAO were tested for two years in both the rice-growing seasons. None of these was found to be promising especially in the last crop season but three, BG 79, Lead 35 and FB 76 (BPI 76) gave good performance in the second crop, the yield of which usually is lower than that of the first crop. Further tests are required.

Thailand. Sixty-seven varieties of different flowering dates were tested in four locations in 1963. Yields were particularly promising in San Pathong (N. Thailand), especially for Peta, FB 120 (Philippines), H 4 (red rice), H 5 (Ceylon), Radin Siak 34 and Hybrid II.

U.S.A. Thirty-two tropical and temperate varieties were tried in row test plots for the first time in 1963 at Crowley, Louisiana. It was noted that most of the indica varieties were tall and subject to lodging, even though they gave high yields. The long and medium to short grain varieties could be distinguished as two distinct groups as regards height, lodging, straw and milling quality.

In the replicated test of 23 of the above varieties, 8 yielded significantly above Nato. However, due to weak straw, low milling quality and type of grain, none of the eight would be suitable for commercial production in Louisiana.

Vietnam. Tests on selected early, medium and late maturing native varieties were carried out in all the rice-growing provinces. These were chosen as particularly adaptable, and seed multiplication has been started. Further tests have now begun on another set of local and foreign varieties.

Discussion and Recommendations

The variety CH 1039 was found to be highly shattering in Kashmir. This defect was observed to a lesser extent in France probably because the harvest is carried out before the grains are completely mature. In Japan, no trials have so far been made due to quarantine restrictions. The Burmese varieties in general have been found to have stiff straw and good yield in several countries. The variety which gave high yield in San Patong in Thailand, Hybrid II, has been noted to be particularly resistant to blast in India. In France the problem of lodging is of lesser importance because of the recent improvement in threshing machines, but the work is slower and consequently costlier. In the U.S.A. the prevalent climatic conditions prevent the use of such lodging varieties. In conclusion, it was suggested that new varieties as reported by member countries should be included in future tests, but that varieties in these tests should be grouped according to their suitability to the different climatic regions.

The Working Party, realizing the importance of co-operative trials and noting that the results to date have shown that the same varieties have given good yields in a number of countries, recommended that these trials should be continued and expanded. Member countries are requested to report to the I.R.C. all new promising varieties and to make seed of these available to other participating countries.

Breeding Procedures for Yield and other Economic Characters

Two key papers were presented on this subject, one from Japan and one from Ceylon. Related to these were others on breeding for nitrogen responsiveness and plant type, on resistance to Hoja Blanca from U.S.A., and on other economic characters from Australia and India.

Past breeding work in Japan was largely confined to the intercrossing of lines among genealogically related parents, resulting in varieties derived mainly from two groups, Rijuu No. 132 and Asahi. In recent years, there is a conscientious effort to make distant crosses for further improvement, especially in breeding for disease resistance. Efforts are also being made to preserve the germplasm of old, native varieties.

The bulk method is becoming an increasingly popular method of selection among Japanese breeders, especially when yielding ability is the main concern. The papers from Japan deal with theoretical considerations to compare the pedigree, bulk and backcross methods in the light of various breeding objectives. It is cautioned that in adopting the bulk method, attention should be given to adequate population size, effect of natural selection on different genotypes, relation between competitive ability and yielding ability, and to the testing procedures for selected plants. The usefulness of heritability estimates, genotypic correlation between economic characters and information on the genotypic structures of hybrid populations at successive generations are also discussed in relation to the problem of choosing the most effective breeding procedure. Of particular interest to rice breeders are the techniques of shortening the breeding cycle. These include (1) the use of short photoperiods, (2) embryo-culture of crossed seeds, and (3) mass selection in F_2 for heading date. With the adoption of such techniques much of the advantage claimed for pedigree as against the bulk population method vanishes.

Results obtained in Ceylon indicate that from F_2 to F_6 generations, in the pedigree method the variance of the dominant component decreases in both between the within lines. While the heritability of genetic variance increases from F_2 onwards, and F_3 is the crucial generation when selecting on the basis of between lines and not of within lines, the genetic variance decreases rapidly with advancing generations as in within lines. In dealing with polygenic characters such as yield, and if undesirable linkage are to be broken, a large number of plants (15,000 to 25,000) will have to be carried on to F_3 and the selection should be on the basis of line performance. The F_3 generation is very crucial as the heritability is strikingly high in this generation and is equal to nearly half of the total increase in heritability obtained by the end of F_6.

It has been argued that there is often in the bulk method loss of valuable genes due to the operation of natural selection in favour of competitive types which are not always the best. Experimental work some years back in the U.S.A. has, however, shown that this was unlikely if care is exercised in eliminating such types, if they could be recognized, in successive generations of the bulk method.

Competition presents a much more complex picture in hybrid bulks than in varietal mixtures, as in the former (a) heterozygosis continuously creates new genotypes, and (b) the final array of homozygotes is extremely heterogeneous. Nevertheless, the rice breeder can confidently assume the survival in hybrid bulks of the complete continuum of variation contributed by the parents, even after as many as 8 generations. Although trends in gene frequency show marked sensitivity to environmental influences, complete loss of any type of gene appears to be extremely rare. The rice breeder can initiate selection in the advanced-generation bulk with the assurance that his gene reservoir is as rich as in the F_2, and that he now possesses the added advantage that the near-homozygotes that compose his bulk exhibit maximum heritability.

In the instance of low-heritability characters like grain yield, various theoretical arguments have been adduced in support of the bulk-population method as against pedigree breeding. Heritability trends in successive selfed generations in rice hybrids provide cogent reasons for postponing the initiation of selection to the F_7, or a later generation, when heritability values would approximate the maximum attainable.

Two papers on selection of suitable plant type and nitrogen responsiveness presented at the symposium on mineral nutrition held at the International Rice Research Institute from 23 to 28 February emphasized the importance of short culmed, erect and narrow-leaved, and medium tillering varieties with early maturity for high responsiveness to fertilizer application. Such varieties have the advantage of receiving full benefit of light for photsynthesis as against tall and late maturity varieties. The present commercial *indica* varieties of tropical Asia are of the latter type, but the Taiwan variety Taichung Native No. 1 has the desirable characteristics. This habit type is controlled by a single recessive gene without unfavourable linkages and could be easily introduced by suitable back-cross methods with the most important commercial varieties of tropical regions.

In Australia, one of the important breeding objectives is selection for high grain-straw ratio and responsiveness to fertility. Emphasis is placed on short, stiff straw with short, erect, narrow leaves and on high responsiveness to fertilization.

In the U.S.A., breeding for Hoja Blanca resistance is an important objective, although many short grained *japonica* varieties were found to be resistant to the disease. All of the long grain varieties grown commercially in the South were found to be susceptible. Therefore, many crosses were made between susceptible long-grain and resistant short and medium grain varieties. One of the difficulties met in breeding for resistance was that wild populations of *Sogata orizicola* Muir, the only known insect vector, contained only a small percentage of insects capable of virus transmission. A strain of high percentage of viruliferous individuals was developed by selective mating. By repeated backcrossing to long grain parent and by selecting for resistance, an advanced generation of long grain selections that are homozygous for resistance have been evolved and these are being currently evaluated for blast resistance and other desirable agronomic, cooking and milling characteristics.

Discussion and Recommendations

Recently in Japan the bulk method is preferred to the pedigree method. To avoid the danger of loss of valuable genes by natural selection, an equal amount of the seed for each plant should be carried forward. The advantage of selection of plants with early or medium maturity in relation to yield was indicated.

The methods of speeding up breeding in Sierra Leone were described, including the breaking of dormancy by heat treatment, the forcing of early heading by dense sowing and the giving of short-day light periods and the rapid multiplication of hybrid material by vegetative propagation in culture solutions.

The Working Party *recommended* that (1) all member governments should examine their existing breeding methods in the light of the modern techniques which have been described, and should revise these methods where necessary, keeping in mind their individual breeding objectives, the facilities they have available and their particular local conditions, (2) care should be taken in all member countries to preserve local varieties which may carry genes useful for future breeding programmes, and (3) in all member countries where high fertility levels are possible, particular attention should be paid to breeding suitable plant types.

Report on the Symposium on Rice Genetics and Cytogenetics

A symposium on Rice Genetics and Cytogenetics was held at the International Rice Research Institute, Los Baños, Laguna, Philippines, from February 4-8 1963. This was the first of a series of international conferences of the Institute on broad research areas in rice and was solely devoted to the discussion of rice genetics, cytogenetics and taxonomy.

The aims of the symposium were to determine the present status of research achievements in the field of rice genetics, cytogenetics and taxonomy, to review areas of agreement and disagreement, and to identify those problems on which future research is most needed. The symposium was preceded by extensive consultations with workers in India, Japan, Taiwan, U.S.A. and with the representative of the International Rice Commission.

The symposium was moderated by H.H. Kramer of the University of Nebraska and was attended by 102 persons representing 26 institutions and organizations from nine nations. Twenty-one invitational papers were presented in the following six fields: (1) taxonomy of the genus _Oryza_; (2) chromosome morphology in _Oryza_ species; (3) genetic and cytogenetic evidence for species relationships; (4) nature of intervarietal hybrid sterility in _O. sativa_; (5) inheritance studies, gene markers and linkage groups in _O. sativa_; and (6) gene symbolization and nomenclature in _O. sativa_

As regards research meriting strengthened or new efforts in the future, the following areas were agreed upon: (1) Extensive genetic analysis of economic traits, especially of physiological and quantitative characters of importance to plant breeders. (2) Development of more complete linkage maps, both in _indica_ and _japonica_. (3) Completion of a set of trisomics and a set of translocation heterozygots within a single _japonica_ variety, within a single _indica_ variety, and within a single "ponlai" variety. (4) Clarification of the nature of intervarietal sterility, using both cytogenetic and genetic approaches, with special emphasis on studies on leptotene, pachytene, and diplotene. (5) Extension of studies of genome analysis to species in sections other than _O. sativa_ , which is relatively complete, and the utilization of amphidiploids. (6) Clarification of species relationships still in dispute; further collections of African material are necessary. (7) Studies on the inheritance of resistance to _Piricularia oryzae_, to stem borers and to other important diseases and pests. (8) A continuing and thorough search of the world collection of rice varieties for characters of interest to taxonomists, geneticists, and plant breeders. (9) Preservation of genetic material used in important genetic studies, particularly those stocks used as analysers; these might be deposited with IRRI for later use by scientists wishing to verify earlier results or to make comparative genetic studies. (10) Genetic studies on hybrid populations and on the interspecific transfer of desirable traits.

A number of committees were appointed to study special problems and to resolve controversies. In one of the committees it was agreed to send on a co-operative basis two collection teams to Africa to augment the existing collections of *Oryza* species and strains for experimental studies. One team will collect material in east Africa and Madagascar for taxonomic studies, while the other will study cultivated and wild-growing populations in north-central Africa. Duplicate plant and seed samples collected will be deposited at IRRI and later will be made available to interested workers anywhere.

There was agreement on the need to adopt a standard system of nomenclature for *Oryza* species, and for genome designations and gene symbols. In the case of genome symbols, the conferees adopted the IRC-recommended rules of nomenclature and symbolization (cf. IRC Newsletter 8(4); 1-7, 1959). For those gene symbols which have appeared in the rice literature since 1959, in compliance with the IRC resolutions, future compilations will be made by the International Rice Research Institute. Monitoring of new gene symbols is being executed by the Institute and will be announced regularly in the IRC Newsletter (cf. December 1963 issue).

In the case of the taxonomic nomenclature, the committee recommended the recognition of 19 valid species in *Oryza* and that additional studies be conducted on five other species of doubtful validity. For the complex of *O. sativa* v. *fatua* (or *f. spontanea*) and *O. perennis*, the symposium recommended the tentative adoption of the following classification and nomenclature: *O. sativa* v. *fatua*, *O. perennis* subsp. *cubensis* (American form), *O. perennis* subsp. *balunga* (Asian form) and *O. perennis* subsp. *barthii* (African form). It is also recommended that future reference to any of these forms should include listing of their appropriate synonyms.

The symposium recommended compilation by IRRI of an illustrated booklet on the nomenclature of plant parts and the description of genetic mutants.

The 21 invitational papers are being published by the Elsevier Co. of the Netherlands as Proceedings of the symposium.

Upland Rice - Its Culture and Significance

Papers on this subject were presented from Brazil, Fiji, Indonesia, Japan, Philippines, Sierra Leone and Taiwan. It is apparent that there is much divergence in methods of culture in various places. For example, in Fiji a well-known wet land rice variety is grown as dryland rice, on land which is too poorly drained for sugarcane, while the importance of draining the soil is stressed in Indonesia and in Sierra Leone. It was suggested from Sierra Leone that some definition and standardization of nomenclature in respect to upland rice is needed. A primary distinction is its growth on aerated soils throughout its life period as opposed to the waterlogged soils on which wet land rice is grown. The upland soils have a high rate of organic matter decomposition and rice cannot be grown continuously but must be rotated either with other crops or with fallow.

Upland rice culture varies from the cultivation on forest land in Indonesia (shifting cultivation) making use of the fertility of the soil built up by long periods of forest growth, to the bush fallow rotation system of West Africa which seeks to strike a balance between the fertility build-up and its utilization. The Indonesia system was not successful because fertility of the soil has been so reduced that it must be built up again by adding organic manures for continuous cropping in rotation with grass leys and other crops as described from Brazil, Fiji and Japan. Also, the development of more stable upland arable farming has increased pests and diseases which are of greater importance in countries with more advanced cultural practices. Weeds are also a problem in upland rice culture. All these factors make continuous upland rice culture impracticable, although it can be more easily mechanized and can be grown with lower labour requirements than wet land rice.

Yields of upland rice vary greatly from country to country: from 900 kgs. per hectare in Sierra Leone to 6,000 kgs/ha obtained experimentally in Brazil. Average yield in all countries, however, appears to be less than half the average yield of wet land rice. Obviously, improvements can be made by breeding, the introduction of high-yielding varieties, the use of fertilizers and by improved cultural practices. Much has already been done and every country has been able to increase yields experimentally. With attention only comparatively recently focussed on upland rice, there is no reason why considerably higher yields should not be obtained by more intensive studies. While upland rice cultivation will probably never be more than a fraction of the importance of wet land rice in the world as a whole, it cannot be ignored; indeed, in some countries, it is of very considerable importance. The future is likely to see its extension - not on the older methods of soil exploitation but on sound modern farming methods - particularly in countries without adequate irrigation facilities for wet land rice, where rice is a staple food and where low population density requires full mechanization of cultivation. Development of proper rotational systems for effective farm management can make upland rice the major cereal. The scope of its development from country to country will, however, vary widely and be largely dependent on climatic factors, in particular on the amount and distribution of rainfall and on the soil.

Discussion and Recommendations

In Japan, it is thought that some toxic substances from the rice roots persist in the soil and that this makes successive cropping of rice impossible. Successive cropping also results in the build-up of nematodes. While during vegetative growth, drought may not seriously affect yield, it is very necessary that sufficient moisture be available from rain at flower initiation and at the heading stages. There was some discussion on the adaptability of varieties to both upland and swamp conditions. While in Japan and Sierra Leone, upland rice varieties were not found to grow well under swamp conditions, in India, Australia and the Philippines such varieties gave good yields under irrigated, submerged or flooded conditions; the reverse has been stated to be true in U.S.A. and South America.

There was considerable discussion on the standardization of terminology regarding upland varieties. There are remarkable differences in physiology between upland and lowland varieties in Japan. In particular, in upland varieties, the seeds germinate in solutions of high osmotic pressure, the osmotic pressure of the roots is higher, and anatomical characters, especially the ventilating systems of the roots, are quite distinct.

The Working Party, considering the complexity of the varietal position of upland rice and the varied conditions under which it is cultivated, recommended that: (1) intensive studies be undertaken on the physiological and morphological characteristics of lowland and upland varieties; and (2) measures be taken to determine suitable rotations and fertilization to maintain soil fertility and to avoid the necessity for fallowing systems and shifting cultivation.

Rice Blast Disease

This is one of the most important diseases of rice and the Working Party devoted a great deal of attention to it. In addition to progress reports from Australia, Hong Kong, the Philippines, Thailand and Vietnam on the Cooperative Uniform Blast Nursery Tests, there were presented five general papers as follows:

1. The present status of the rice blast problem in Southeast Asia.
2. FAO/IRC 1962 Uniform Blast Nurseries Results.
3. The International Research Program on the Rice Blast Disease.
4. The Symposium on the Rice Blast Disease.
5. Problems of Rice Blast Requiring Further Attention: a concluding survey to the Symposium on the Rice Blast Disease.

The following is a summary of the present status of the disease in Southeast Asia. The detailed results of the cooperative nursery studies will be published in the IRC Newsletter from time to time.

Blast disease of rice was not considered important in the tropical countries of Southeast Asia until recently. But the intensification of rice cultivation, the increased application of fertilizers, and the cultivation of varieties which are not blast-resistant, have made the disease increasingly important. It is now realized that when susceptible varieties are planted in high fertility soils, outbreaks may occur when weather conditions are favourable for the disease.

Breeding of resistant varieties is the most promising approach to the solution of the blast problem. It is necessary that all rice varieties which are released for cultivation by member governments should be screened for blast resistance before they are released. For the purpose of screening for blast resistance, a uniform procedure for testing and scoring was suggested by the International Rice Commission in 1961. This was further modified during the Blast Symposium held last July at the International Rice Research Institute. The procedure is very simple and is described in Dr. Oris' paper mentioned above: The International Research Program on the Rice Blast Disease

As a result International Cooperative Uniform Blast Nursery Trials are under way in 15 countries. These trials have as their most important objective the isolation of varieties resistant to the physiological races of the blast fungus which occur in almost all countries.

The International Rice Research Institute has selected for the uniform blast nursery trials about 250 varieties including the 38 differential varieties used in Japan, Taiwan and the United States and about 100 varieties originally included in the International Uniform Blast Nursery trials of 1962. The Institute will supply seeds and details of the testing procedures to the participating countries.

Extensive studies on the occurrence of the physiological races are underway in Japan, Taiwan, the U.S.A. and India. There is a need for establishing an international set of differentials for race identification. Where facilities are not available for the identification of the races, help may be obtained from the centres listed below which will accept diseased specimens. The information on races identified by laboratories will be transmitted to all interested countries.

1 Dr. Frances Latterel
Fort Detrick
Frederick, Maryland
U.S.A.

2. Dr. T. Kosaka
National Institute of Agricultural Sciences
Yokohama Plant Quarantine Office
Hanoda Airport, Branch Station
Tokyo,
Japan

3. Dr. Roy C. Adair
U.S. Department of Agriculture
Beltsville, Maryland
U.S.A.

A Symposium was held at the International Rice Research Institute from 7 to 12 July 1963 on the rice blast diseases. It was attended by 49 specialists from 32 institutions and 15 countries. The objective of this Symposium was to (1) promote international awareness of the blast disease; (2) review research achievements and identify problems on which work is most needed; (3) encourage the development and use of resistant varieties; and (4) design an effective international research programme.

Twenty-nine papers were presented at the Symposium covering various aspects of the blast disease: (1) the fungus; (2) the disease and its development; (3) physiological races, (4) mechanism and genetics of resistance; (5) breeding for blast resistance; and (6) control by chemicals and cultural practices. These papers will be published in the near future.

Discussion and Recommendations

The variety S.67 from India was resistant in 1962-63 in all the centres where it had been tested. Some varieties were resistant in some regions but susceptible in others; 30 varieties which were resistant in tropical countries were found susceptible in the temperate region and *vice versa*. The results obtained are most encouraging but these should be confirmed before definite conclusions could be drawn. Varieties like S.67, which are resistant to all the races, may constitute a most valuable breeding material.

As regards the observed difference in the reaction of the same variety to leaf-blast and to neck blast, it was suggested that the explanation might lie in the existence of different pathogenic races of the fungus at the two stages of crop growth.

Control of Stem Borers

The most important stem-borers in Asia and the Far East are *Chilo suppressalis* Walker, *Chilotraea polychrysa* Mayer, *Schoenobius incertula* Walker, *Scirpophaga innotata* Walker and *Sesamia inferens* Walker. The following is a brief summary of progress achieved in their control.

Varietal resistance. The International Rice Research Institute has initiated a co-operative programme for the selection and/or development of resistant rice varieties. Up till now about 30 such varieties have been selected with a varying degree of resistance which merit further testing, before they can be recommended for commercial use. In experimental plots, some of the more resistant varieties had a total larval population 5 to 6 times less, and yielded about twice as much grain than susceptible varieties.

Limited experiments were also carried out in 1962 at the Maligaya Experiment Station of the Plant Industry Bureau of the Philippines on 44 local varieties. The degree of infestation varied from 0.12% for the variety Apostol to 7.62% for the variety BE-3.

Chemical control. In the Philippines, chemical control tests were carried out by the Bureau of Plant Industry in various localities and the most suitable insecticides were determined and recommended for use. During the 1962-63 season, about 61,000 ha were sprayed twice, out of 71,000 ha infested with borers, and the results were most satisfactory.

Control experiments were also carried out at the UP College of Agriculture. Out of 7 insecticides tested, Endrin at 5 ml and Thiodan at 7.5 ml per gallon of water had each reduced "dead heart" infestation considerably. However, all insecticides tested had also reduced significantly the percentage of the "white heads". In general, all applications have given significantly better yields than the controls. On a per hectare basis, treatments with Endrin yielded 6.7 tons; Thiodan 6.7 tons; EPN 6.1 tons; Zeotran 6 tons; Lebaycid 5.5 tons; Sevin 5.3 tons; and with Folidol 5 tons; the controls yielded 4 tons per ha.

In Japan the chemical control of the stem-borers is increasing and this has resulted in a remarkable decrease in crop losses. Parathion and benzine hexachloride (BHC) are still the leading insecticides but they are being slowly substituted with organic phosphates of lower mamalian toxicity and with BHC formulations which are applied on the water or on the soil surface.

Recently concluded tests showed that helicopter applications of BHC granular formulations are more promising over dusting because of their ease of application and their lesser adverse effect on useful organisms. Extensive chemical control applications caused in some cases abnormal increases of the green, white and gray bafed hoppers, especially where BHC was applied as dust.

Biological control. In the Philippines, the egg parasites *Trichogramma minutum* Ash., *T. australicum* Girault, *T. japonicum* have been bred in the laboratory in large numbers and released in various localities of the country. These parasites have been established but their respective effectiveness has not yet been determined. Twenty-three hymenopterous and one dipterous parasites have been reared from *Chilo suppressalis* Walker and *Schoenobius incertulas* Walker. The egg parasite *Phanurus* sp. was found to parasitize 14% to 50% of *Chilo suppressalis*.

The Cuban fly *Lixophaga diatraeae* Townes has been found in the laboratory parasiting successfully the larvae of *Chilo suppressalis*. Field releases of this fly have been made but the results are not yet known.

Cultural control. In the Philippines, whenever possible, the following cultural methods have been applied as a supplementary method to chemical control: (i) collecting egg masses; (ii) using light traps; (iii) destroying infested seedlings; (iv) using clean cultures to eliminate alternate hosts; (v) flooding infested rice fields after harvest; (vi) burning of rice stubbles.

Discussion and recommendations

The merits of the various methods of control were discussed and it was agreed that no specific recommendations should be made with regard to insecticides and to the concentration to be used as these are to be determined under local conditions. As regards resistance to stem-borer attack, the Working Party urged that the work initiated at the IRRI should be continued and that the promising varieties as well as those developed locally should be tested by participating countries against different borer species. Very little is known on the genetic linkage of borer resistance with other known varietal characteristics and this aspect should be pursued experimentally. It was mentioned that in Japan silicification of the plant was found to be a most important character for resistance to borers and to other insects. Efforts should be undertaken to breed borers under laboratory conditions.

The Working Party hoped that the International Rice Research Institute will undertake the coordination of cooperative studies on resistance, standardizing procedures and methods for evaluation; it felt that, whenever possible, the same varieties should be used in these studies.

Rice Nematodes

A review by M. Ichinohe of research work on rice nematodes was presented. Little work has been done concerning these nematodes but the main species are:

(1) The white tip nematode, *Aphelenchoides besseyi*. This is the most thoroughly investigated nematode attacking rice. It occurs within the young unfolded leaves and in the spikelets and grains. Affected plants are often stunted. Seed infection reduces and delays germination. It also attacks other plants including *Setaria viridis*, *Panicum sanguinale*, *Cyperus iria* and *Setaria italica*. It is known in Japan on both lowland and upland rice and also occurs in El Salvador, India, East Pakistan, U.S.A. and several other countries.

(2) The rice stem nematode, *Ditylenchus angustus*. It causes the "ufra" disease and feeds on the young ears, leaf sheaths and young leaf blades, where yellowish or whitish-green patterns are formed. In India, it can cause up to 50% damage. It also occurs in Thailand and possibly in Burma and the Philippines.

(3) The rice root nematodes, *Hirschmannia* (*Radopholus*) spp. The species *H. oryzae* has been the subject of extensive studies in Indonesia, where it is associated with the serious "Mentek" disease. In Japan, in addition to rice, 25 other plants are known to be hosts of this species which also occurs in Madagascar, East Pakistan and U.S.A. *H. spinicaudatus* occurs on rice in Cameroun.

(4) The rice stunt nematode (*Tylenchorhynchus martini*) occurs in rice-growing soils in U.S.A. and has also recently been found in East Pakistan.

(5) The rice cyst nematode (*Heterodera oryzae*) has been described from the Ivory Coast, where it is parasitic on lowland rice. A species of *Heterodera* has also been found attacking upland rice in Japan.

(6) Species of root-knot nematodes (*Meloidogyne* spp.) affect rice roots in several countries including Japan and South Africa; it is also found in the U.S.A.

The white tip disease, caused by *A. besseyi*, has been found in the Northern Territory of Australia. Recent surveys in the Philippines revealed the presence of *A. besseyi* and *Hirschmannia oryzae*, and an undescribed species of *Helicotylenchus*. In Thailand, the root-knot nematodes *M. javanica* and *M. exigua* have been found attacking rice as well as weeds growing in rice fields. In India, the Central Rice Research Institute isolated the following parasitic forms: A. besseyi, M. incognita acrita, Helicotylenchus crenatus and Tylenchus goodeyi. In a test of the reaction of 31 varieties to M. incognita acrita, the number of galls per plant ranged from 0.7 to 53.5. The hot water treatment, soil fumigation and chemical treatment of seedling roots against A. besseyi, all resulted in yield increases.

Discussion and recommendations

Most of the nematodes associated with rice had been recorded in only a few countries, although they are probably quite widely distributed. Aphelenchoides besseyi had been quite thoroughly investigated but very little information is available on the other nematodes attacking rice. As several of these are capable of causing significant damage, it was recommended that research on the root- and leaf-infesting nematodes of rice should be intensified. It was further recommended that surveys should be carried out to determine the distribution of known parasitic nematodes of rice and to discover any other parasitic species which may not yet have been observed. Wherever possible, such surveys should be conducted by nematologists but where this cannot be done, advantage should be taken of the offer of Dr. Ichinohe of the Nematology Laboratory, National Institute of Agricultural Sciences, Nishigahara, Kita-ku, Tokyo, Japan, to accept for identification specimens collected from rice in various countries. In this connection, FAO was requested to circulate instructions on methods of collection, preservation and despatch of nematode specimens.

With reference to the need for intensified research on parasitic rice nematodes, mention was made of the lack of trained nematologists in most rice-growing countries. It was therefore recommended that governments should give attention to the possibility of sending suitably qualified personnel to appropriate centres for specialized training in nematology.

Attention was drawn to a recommendation of the Fourth Meeting of the Plant Protection Committee for the Southeast Asia and Pacific Region, held in June 1962, in which it was resolved "that all participating governments or territorial administrations within the Region should endeavour to undertake in their respective countries and territories surveys of plant parasitic nematodes; and should, where these are not already available, train and secure the requisite specialists for such surveys". The Working Party endorsed this recommendation of the Committee and urged its implementation.

Virus Diseases of Rice

The Working Party reviewed information on the virus diseases of rice and their importance and concluded that there is a great need for experimental studies on the nature of these diseases particularly in Asia and the Far East. The following table shows the area infested with three virus diseases and the losses they cause in Japan:

DISEASE	YEAR			
	1962		1963	
Dwarf	115,000 ha	17,000 tons	101,100 ha	13,000 tons
Yellow drawf	29,000 "	21,000 "	21,000 "	9,000 "
Stripe-disease	112,000 "	31,000 "	153,000 "	37,000 "
Total	256,000 ha	69,000 tons	275,000 ha	59,000 tons

The most important virus diseases are:

1. Yellow Dwarf

In Japan it is very important and is most severe in the south-western regions including Kyushu. In Taiwan it is found mostly in the northwestern regions; in the Philippines it is of little importance and attacks mostly upland varieties.

The virus is transmitted by the leaf-hoppers Nephotettix cincticeps Uhler, N. bipunctatus Fabr. and N. apicalis Mots.

In one experiment in Japan, the incidence of infection varied from 11% to 69% while in another out of a large number of varieties tested, 36 escaped the disease and these are now being investigated further in the greenhouse.

2. Dwarf or Stunt Disease

This is one of the most important diseases of rice and has been known in Japan since 1897. It occurs all over the country except in Hokkaido and Tohoku, but it is most destructive in Southern Kyushu. In the Philippines it is known since 1940 but recent transmission studies at the IRRI throw some doubt on the similarity of the disease in the two countries.

The confirmed vectors of this virus are the leaf-hoppers Nephotettix cincticeps Uhler, N. apicalis Mots and Inazuma dorsalis Mots.

3. Black-streaked Dwarf

This disease appears to be endemic in some regions of the Kanto-Tosan, Shikoku and Kyushu of Japan. It also affects corn, wheat and barley, often causing severe losses in corn.

The black-streaked dwarf is also known as leaf gall disease because it is usually found in association with leaf galls. Recent studies, however, have indicated that these galls are caused by direct insect injury and not by a virus.

4. Tungro Virus

This is probably the most important virus disease of rice in the tropics. It was first reported in Albay Province of the Philippines and again in Central Luzon in 1941 but was not confirmed until 1959. It can cause up to 30% loss of the crop.

The disease is also important in North Borneo and it is believed to be found in Malaysia but this is yet to be confirmed by transmission tests. In the Philippines it is transmitted by the leaf-hopper Nephotettix apicalis Mots.

5. Transitory Yellowing

Reported from the southern and western regions of Taiwan it is called transitory because of the recovery of diseased plants under certain conditions. In 1962 the disease extended to about 26,000 ha but in 1963 it affected only about 3,660 ha.

This disease was also known as "suffocating" disease but recent evidence shows that this condition is not caused by this virus although at times this virus was also found on the same plants.

Some investigators believe that this disease and the Tungro virus are identical; under controlled experiments they are both transmitted only by Nephotettix apicalis Mots. Further work on the identity of the disease is needed.

6. Orange-leaf Virus

The Orange-leaf virus usually occurs together with the Tungro virus and because of the similarity of symptoms they were thought to be the same disease. Transmission experiments indicate that it is caused by a different virus and is transmitted only by Inazuma dorsalis Mots.

It attacks upland as well as lowland rice and has been reported from various parts of the Philippines, northern Thailand, and Malaysia; it is probably found also in Taiwan.

7. Stripe-Disease

It is found almost everywhere in Japan except for Hokkaido and northern Tohoku.

It is transmitted by Delphacodes striatella Fallen.

8. Mosaic

The mosaic virus was first reported on rice in the Philippines in 1960. It can be transmitted mechanically to corn and is believed to be similar to the mosaic disease of grasses.

9. Hoja Blanca

It has been recently reported in the U.S.A. but it is serious only in Latin America. Cooperative field trials on the reaction of many rice varieties and breeding lines were carried out in Cuba, Venezuela, Colombia and other countries in Central and South America. Progeny of hybrids of resistant and of susceptible varieties were tested under controlled conditions in the U.S.A. and progress has been made in the development of resistant long-grain varieties adapted to mechanized production. Inoculation was difficult at first because only a small percentage of the naturally occurring insect vector, Sogata orizicola Muir, could transmit the virus. Selective breeding of the insects resulted in the development of highly virulent strains for greenhouse testing.

Long-grain selections that are homozygous for resistance to the hoja blanca are now being evaluated in the U.S.A. for commercial purposes.

10. Yellow Disease of Rice

This is found in the Philippines and can be transmitted by leafhoppers but little is known on the nature of the virus. It is under investigation.

Control

With some viruses proper timing of seeding and transplanting may result in escape of infection. The control of vectors is also at times effective, both in seedbeds and in the field but these are only temporary measures.

Very little is known on the virus diseases of rice and especially in tropical Asia, Africa and the Near East. A detailed survey of these diseases is therefore of primary importance. Necessary quarantine measures should be taken in order to prevent the introduction of the viruses and/or their vectors in new areas.

Discussion and recommendations

At present the only method of controlling virus diseases is the control of their vectors. Some varieties show resistance to some viruses but there is no variety that is immune to all viruses. In view of the importance of the viruses and the need for scientific research concerning their nature, the International Rice Research Institute has initiated in 1962 studies on Rice Viruses and welcomes the cooperation of all governments.

Epidemiology of Rice Diseases and Pests and its Forecast

Japan

(a) Stem borers

In 1941 a Forecasting Service of the Diseases and Insect Pests of Rice and other food crops was established by the Ministry of Agriculture and Forestry in order to make a detailed survey of the occurrence and the intensity of various insect pests. By 1963 more than 2,700 light traps were operating throughout the country for this purpose. The collected specimens were identified and the various factors affecting the intensity of the occurrence of these pests were determined. These factors are: (1) weather; (2) nature of soils; (3) action of parasitic and predatory agents; (4) soil fertility; (5) chemical control and larval physiology on the date of occurrence. The peak of adult emergence is of utmost importance as regards timing of insecticide applications.

(b) Diseases

Forecasts on the occurrence of the blast disease are based on trapped spore counts, field assessments of the disease and on weather conditions. In southern Japan, however, spore trap counts are of lesser importance.

Forecasts on the intensity of the bacterial blight is based on periodic assays of specific bacterial bacteriophages in irrigation water, while the sheath blight is determined on the basis of macro and micro-climatic conditions.

Forecasts of virus diseases are based on the density of the leaf-hopper vectors at certain time of the year and on the degree of their infectivity as determined by transmission studies.

In brief, weather conditions seem to be one of the most important factors determining the accuracy of forecasting which is already about 70%; the studies will continue.

India

(a) Borers

The incidence is high in crops receiving high levels of nitrogen, in crops grown at highly acid soils (pH 4.0 to 4.8), and in widely spaced seedlings, i.e. 30 x 30 cms. Temperature and relative humidity at the base of the culms have a direct relationship to the prevalence of the moths. The first brood emerges in October/November and reaches its peak when the mean maximum temperature is about 29°C and the relative humidity from 78% to 89%. Maximum emergence of second brood adults in February/April occurs at a maximum temperature of 35°C and relative humidity from 55% to 59%.

(b) Gall fly

The high incidence of the gall fly occurs about 60 days after transplanting. Infestations are favoured by high levels of nitrogen, phosphorous and potash. In contrast to the borers, the incidence of gall fly is higher in alkaline soils (pH 8.0 to 9.0). Temperature at 31°C and relative humidity at 84% are the most favourite for emergence.

(c) Hispa

Occurred in epidemic proportions during October 1962. The weather was rather dry and the maximum temperature varied from 30.7°C to 32.5°C.

(d) Blast

This disease is epidemic in areas where night temperatures are low (20°C to 24°C) and relative humidity is high causing abundant dew formation. This condition occurs in the north in early September and in the south in December to January.

(e) Helminthosporium

The plants become most susceptible in the advanced stage of their development and the disease is most severe during October to March, under light rains and cloudy weather. The disease is favoured by cool nights (20 to 24°C), heavy dew formation and low sunshine for more than 10 to 14 days during the months of October to December. Spore counts are an important factor in forecasting severity.

Plant Quarantine

In almost every item discussed by the Working Party the question of sending rice seed from one country to another has arisen. Such movement of seed is required, for example, for carrying out cooperative variety trials for adaptability, blast resistance and stemborer resistance, for the dissemination of improved material and for the distribution of breeders' stocks for selection under varying conditions. In most countries plant quarantine regulations are in force and in some areas there are, in addition, regional plant quarantine agreements. These result in the restriction of free movement of rice seeds and there is, therefore, a possibility that the programme of work desired by the Working Party may, in some cases, be hampered or delayed by the necessity for the regulation of plant imports. Consideration was therefore given by the Working Party to plant quarantine as it impinges on rice improvement and investigational programmes. In addition, ways in which plant quarantine regulations might possibly be safely amended in future were discussed.

Consideration was given to the diseases, insect pests and nematodes which could be transported with rice seeds and it was recognized that, although there has in the past been extensive movement of rice seeds among countries, yet there are still many pathogenic organisms which are of limited distribution. It is therefore essential that plant quarantine restrictions should take into account the following procedures:

1. Normal Inspection - This is a useful procedure with rice as with other seeds but will only eliminate a proportion of the dangerous organisms.

2. Treatment - Chemical and heat treatments are partially effective in killing pathogens and insects but do not give complete protection and so can only be a useful (and important) adjunct to other quarantine measures.

In addition to these the following measures are also considered necessary for complete quarantine safety:

3. As far as possible, seeds should be obtained from areas in which the most dangerous pests and diseases are absent.

4. Only small quantities of seeds should be introduced.

5. All imports should, for maximum safety, be subjected to post-entry quarantine, only seeds from plants grown from the original importation being released.

Discussion and Recommendations

The application of the above measures, while necessary for complete quarantine protection, may severely limit the movement of rice seeds. Methods by which movement of seeds might ultimately be made easier were, therefore, considered. It was regarded as important that detailed lists of rice pests and disease in member countries, compiled where necessary through special surveys, should be made so that, with more precise information on the present distribution of these pests and diseases, certain blanket restrictions might be revised in future. Attention was drawn to the "Preliminary List of Insects and Mites recorded on Paddy Rice" prepared by FAO as a first step in assembling information on the geographical distribution of rice pests.

The desirability of evolving more effective seed treatment methods was also emphasized, particularly concerning the possibility of using hulled seeds which might be more easily freed of dangerous organisms.

As regards post-entry quarantine, the lack in many rice-growing countries of post-entry quarantine facilities was mentioned. This difficulty might be overcome by arranging for existing quarantine stations to accept material destined for neighbouring countries, although the most essential development in this respect is the establishment in all countries as soon as possible of efficient quarantine stations.

Considering these matters, the Working Party recommended that:

1. As complete information as possible on the rice pests and diseases occurring in member countries should be compiled, if necessary by carrying out further pest and disease surveys, so that quarantine procedures affecting rice seeds may be rationalized.

2. Investigations should be intensified into effective methods of seed treatment acceptable to quarantine authorities. Attention should be given particularly to investigations with hulled rice.

3. Regional plant quarantine organizations should encourage the establishment of efficient regional quarantine stations for the use of groups of territories with inadequate facilities of their own.

The Proposed International Rice Year

The topic was introduced by the Technical Secretary who outlined the background of the proposal and summarized the objectives related to it. A special FAO Working Paper on this subject was made available to the meeting.

Because this topic was also to be dealt with at the joint session with the other Working Parties, when the possible role of FAO would be outlined, the delegates at this Working Party meeting were asked to direct their remarks to desirable action projects and programmes that might be conducted by individual countries and by organizations. The following is a summary of the comments by delegates who spoke on this subject.

India. The proposed rice year coincides with the inauguration of India's next 5-year plan. This and other events could be scheduled for 1966 and used to focus attention on rice.

Japan. It is difficult to be quite specific as to action programmes that could and would arise out of the proposed declaration. If solutions to the problems associated with rice production, distribution, etc. were known now and if the ways and means of implementation were quite feasible, no one would wait for a "Rice Year". Certainly, Japan is willing and ready to cooperate with and share its findings with other nations.

Philippines. "Every year is Rice Year" but possibly more impetus would be given to action programmes. The proposal necessarily has budgetary implications for any country. More publicity, more extension work, more training programmes and other measures, all cost money.

Sierra Leone. An "International Rice Year" could encourage governments to do more towards implementation of certain desirable practices such as the distribution of better seed and the preparation and use of extension material pamphlets, posters, etc. FAO could be invited to assist in the organization of such action.

U.S.A. Although much is now being done, both from the standpoint of publicity and the organization of technical groups, an "International Rice Year" could help to focus even more attention on rice.

From an overall standpoint, the greatest emphasis must be on encouragement for nations to help themselves. Consideration must be directed toward what could be done that is not now being done. It was noted, however, that care must be taken not to withhold possible action now for an International Rice Year in 1966 nor to take hasty measures to meet a 1966 deadline in such matters as, for example, the proper testing of a new variety.

International Rice Research Institute (IRRI). There is general recognition that a great deal more is known about rice production and protection than is being put into practice. Possibly an International Rice Year would focus attention on extension programmes including demonstrations at the farm level as well as providing a medium for added publicity of recommended practices.

There was general agreement on the following:

1. There is a great need for further attention and action on many problems relating to rice.

2. An "International Rice Year" could provide a motive and theme for increased attention to desirable extension activities.

3. Any effective programme would have budgetary implications. The proposed declaration might encourage more support by government authorities when making allocations.

4. A combined FAO/national programme probably offers the best promise of desirable programme implementation.

RECOMMENDATIONS

1. Varietal adaptability

The Working Party realising the importance of cooperative trials on breeding and testing varieties with wide adaptability and noting that the results to date have shown that the same varieties have given good yields in a number of countries, recommended that these trials should be continued and expanded. Member countries are requested to report to the I.R.C. all new promising varieties and to make seed of these available to other participating countries.

2. Breeding procedures for yield

The Working Party recommended that member governments should (1) examine their existing rice breeding methods in the light of modern techniques; (2) preserve local varieties which may carry genes useful for future breeding programmes; and (3) pay particular attention to breeding suitable plant types where high fertility levels are possible.

3. Upland rice

The Working Party considering the complexity of the varietal position of upland rice and the varied conditions under which it is cultivated recommended that (1) intensive studies be undertaken on the physiological and morphological characteristics of lowland and upland varieties; and (2) measures be taken to determine suitable rotations and fertilization to maintain soil fertility and to avoid the necessity for fallowing systems and shifting cultivation.

4. Blast disease

In view of the increasing importance of the blast disease in the tropical areas of Southeast Asia of the need of rice varieties resistant to prevailing physiologic races of the fungus *Piricularia oryzae* and of the importance of identifying the different races, the Working Party adopted the testing procedures which were modified during the Symposium on Rice Blast Disease held on July 1, 1963, and recommended that (1) member countries continue and emphasize the Uniform Blast Nurseries started in 1962 by this Working Party. The programme will be coordinated by IRRI and results will be reported to the Working Party, and (2) member countries study the physiologic races of the fungus in their own countries and send diseased specimens, either leaf lesions or infected rice necks, to the following three laboratories for race studies

Dr. T. Kozaka
National Institute of Agricultural Science
Yokohama Plant Quarantine Office
Haneda Airport Branch Station
Haneda Airport, Tokyo
Japan

Dr. Frances Latterell
Fort Detrick, Frederick
Maryland
U.S.A.

Dr. Roy Adair
c/o Inspection House
U.S. Department of Agriculture
Washington, D.C.
U.S.A.

5. Control of stem borers with insecticides

The Working Party heard with interest that satisfactory control of stem borers has been obtained in Japan and at the International Rice Research Institute with granulated lindane applied in the irrigation water of rice fields. The method seems to cause the least harm to parasites and should be tested elsewhere. In this regard theWorking Party also recommended that whenever insecticidal treatments are applied preference should be given to those insecticides which will do the least harm to parasites.

6. Resistance to stem borers

In view of the recent progress made at the International Rice Research Institute, and in some member countries, in the development of resistant varieties to stem borer attack, the Working Party recommended that these studies be continued and coordinated by the IRRI. The most promising varieties should be made available to participating governments for further testing together with their own resistant varieties. The tests should be carried out under standard testing procedure to be made available by the IRRI upon request.

7. Nematodes

Considering that several of the nematodes attacking rice are capable of causing significant damage, and as complete information on the geographic distribution of rice nematodes is not yet available, it was recommended that: (1) research on root-and leaf-infecting nematodes of rice, including their geographic distribution, should be intensified; and (2) efforts should be made by governments to send suitably qualified personnel to appropriate centres for specialized training in nematology.

8. Virus diseases

In view of the importance of virus diseases of rice in the Far East and the South Pacific Region, the Working Party recommended that surveys be undertaken and studies be initiated or intensified on the nature of the viruses, methods of their transmission, alternate hosts, and on their control through resistant varieties or use of insecticides.

9. Epidemiology

As the timely application of appropriate control measures against rice pests and diseases depends on advance information concerning their outbreaks, it was recommended that investigations be undertaken or expanded in member countries on the factors associated with such outbreaks, and that forecasting stations should be established in as many regions as possible in order to provide the required infortation.

10. Plant quarantine

In order to facilitate the free exchange of seeds of rice varieties while at the same time preventing the introduction of pests and diseases into new areas, the Working Party recommended that (1) as complete information as possible on rice pests and diseases occurring in member countries be compiled; (2) investigations be intensified on the development of effective methods of seed treatment; and (3) regional plant quarantine organizations encourage the establishment of regional quarantine stations for use of territories with inadequate facilities of their own.

11. Field rodents

Although field rodents were not considered at this meeting, the Working Party felt that these are of great economic importance and, therefore, recommended that governments make special studies during the next two years and report the results at the next meeting.

LIST OF WORKING PAPERS PRESENTED OR DISTRIBUTED AT THE MEETING

Australia

IRC/RPP-64/8 The Comparative Performance of the Sub-inda Long Grain Variety Bluebonnet 50 in a Temperate Environment. Australia

- /14 Breeding Procedures for Yield and Other Economic Characters in Northern Australia. E.C.B. Langfield, Australia
- /15 Nematodes in Rice-Humpty Doo, 35 Miles South of Darwin, Northern Territory
- /16 Uniform Rice Blast Nursery, Australia - Present Progress
- /17 Report on Progress of Breeding and Testing Varieties with Wide Adaptability to Northern Australian Conditions. E.C.B.Langfield.
- /27 Preliminary List of Insects and Mites Recorded on Paddy Rice. Harry G. Walker, Australia.

Brazil

- /35 Upland Rice in Brazil and Particularly in the State of Sao Paulo. Derly M. Souza and N.V. Banzatto, Brazil.

Ceylon

- /28 Breeding Procedures for Yield and Other Economic Characters. M.F. Chandratratna. Ceylon.

China

- /20 Report on the Symposium on Rice Genetics and Cytogenetics. T.Y. Chang. China.

Fiji

- /12 The Success of Drilled Dryland Rice in the Fiji Islands. J.D. Yolf and P.L. Rhodes, United Kingdom of Fiji.

France

- /13 Report on a Trial of Varieties with Wide Adaptability in France (1962). France

Hong Kong

- /43 Cooperative Testing of Improved Rice Varieties with Wide Adaptation. P.L.Siak, Hong Kong.
- /44 Cooperative Testing of Blast Nursery. P.L. Siak, Hong Kong.

India

IRC/RPP-64/45 Epidemiology of Rice Diseases and Pests and Its Forecast.
P. Israel, Y.S. Rao and P.S. Prakasa Rao, India

- /46 Rice Nematodes - Host and Parasite Relationship. P. Israel,
Y.S. Rao and V.N. Rao, India

- /47 Breeding Procedures for Yield and Other Economic Characters -
Relation Between Leaf and Neck Infection in Blast.
S.Y. Padmanabhan, J. Veeraraghavan, K.V.S. Kameswar Row, India.

- /48 Epidemiology of Rice Diseases and Pests and Its Forecast.
S.Y. Padmanabhan, India

- /49 Physiologic Specialization in Piricularia oryzae,
Cav. S.Y. Padmanabhan, N.K. Chakrabanti, S.C. Mathur and
S. Veeraraghavan, India.

- /50 Breeding Procedures for Yield and Other Economic Characters.
S.Y. Padmanabhan, India.

- /65 Need for Varieties with Wide Adaptability. All Assistant
Botanists of the Indo-japonica hybridization Scheme,
C. Rice Research Institute, India.

- /66 Certain Consideration in the Breeding of Rice Varieties.
B. Misro and V.R. Balasundaram, India

Indonesia

- /34 Upland Rice - Its Culture and Significance for Indonesia.
H. Siregar, Indonesia.

Iran

- /68 Adaptability of Foreign Varieties to Iranian Climatic
Conditions. Ali Mojitahedi, Iran.

Japan

- /18 Recent Progress of Studies on Hybridization and Selection in
Rice Breeding. Shiro Okabe, Japan

- /24 Rice Virus Diseases in Japan. Tositake Iida, Japan.

- /26 A Review of Studies on Nematodes Attacking Rice -
Minuru Ichinobe, Japan

- /33 Upland Rice - Its Culture and Varieties in Japan. Ryuji
and Toshitada Ono, Japan.

Japan (Cont'd)

IRC/RPP-64/51	Forecasting Attack by Diseases and Pests of Rice. Kasuo Goto, Japan
- /56	Chemical Control of the Rice Stem Borer in Japan. Hidetsugu Ishikura, Japan
- /58	On the Forecasting of the Rice Stem Borer in Japan. Hidetsugu Ishikura, Japan

Philippines

- /1	Cooperative Uniform Blast Nursery Test. Esteban Cada and A. P. Baldeo, Bureau of Plant Industry, Philippines.
- /2	Virus Diseases of Rice in the Philippines and Nearby Countries. S.H. Ou and C.T. Rivera, International Rice Research Institute, Philippines.
- /3	Breeding Rice for Nitrogen Responsiveness. Peter R. Jennings and H.M. Beachell, International Rice Research Institute, Philippines
- /4	The Present Status of the Rice Blast Problem in Southeast Asia. S.H. Ou, International Rice Research Institute, Philippines.
- /5	Need for Modifications of Plant Types. H.M. Beachell and Peter R. Jennings, International Rice Research Institute, Philippines.
- /6	Philippine Rice Stemborers and Their Control. J.L. Morales, A.H. Ramos and H.A. Custodio, Bureau of Plant Industry, Philippines
- /7	Varietal Resistance as a Method of Rice Stemborer Control. M.D. Pathak, International Rice Research Institute, Philippines
- /9	Plant Parasitic Nematodes Found in Rice. Alfredo V. Palo, Bureau of Plant Industry, Philippines
- /19	The Symposium on the Rice Blast Disease. S.H. Ou, International Rice Research Institute, Philippines
- /21	Problems of Rice Blast Requiring Further Attention. Peter R. Jennings, International Rice Research Institute, Philippines.

Philippines (Cont'd)

IRC/RPP-64/22 The International Research Program on the Rice Blast Disease. S.H. Ou, International Rice Research Institute, Philippines.

- /25 FAO International Rice Commission 1962 Uniform Blast Nurseries Results. S.H. Ou, International Rice Research Institute, Philippines.

- /31 Upland Rice - Its Culture and Significance to Local Agriculture. Esteban Cada, Bureau of Plant Industry, Philippines

- /32 Breeding and Testing for Wide Adaptability. Esteban Cada, Bureau of Plant Industry, Philippines

- /57 Testing Rice Varieties for Resistance to Rice Blast. F.T.Orillo, O.R. Exconde, F.D. Fuentes and S.A. Raymundo, College of Agriculture, University of the Philippines, Philippines

- /59 Report on Progress of Breeding and Testing Varieties with Wide Adaptability. P.B. Escuro, College of Agriculture, University of the Philippines, Philippines.

- /61 Studies on the Control of Rice Stemborers. Feliciano B. Calora, College of Agriculture, Philippines

- /62 Some Chlorinated Phosphatic and Carbamate Insecticides in the Control of Rice Stemborers. Feliciano B. Calora and Mateo P. Perino, College of Agriculture, University of the Philippines, Philippines..

- /64 Studies on Rice Diseases in the Philippines. T.G. Fajardo and H.T. Borgonia, Bureau of Plant Industry, Philippines.

Sierra Leone

- /36 Upland Rice - Its Culture and Significance in Sierra Leone. H.D. Jordan, Rokupr, Sierra Leone, West Africa.

Taiwan

- /11 Upland Rice in Taiwan. Chang Chien-pan, Taiwan

- /23 Virus Diseases in Taiwan. Ren-jong Chiu, Taiwan

- /63 FAO Cooperative Trials of Rice Varieties with Adaptation - Compiled by Plant Industry Division Chinese-American Joint mmission on Rural Reconstruction.

Thailand

IRC/RPP-64/38 Report on the Progress of Breeding and Testing Varieties with Wide Adaptability. S. Awakul and Dasamanda, Bangkok, Thailand

- /39 A Preliminary Study on Seasonal Abundance of Major Rice Insect Pests in Thailand. Tanongchit Wongsiri, Waree Paranatee and Chalermwong Thirawat, Thailand.
- /40 Rice Root Knot Nematodes and their Host Plants. Prakob Kamjanasoon, Thailand
- /41 Reports on the Progress of the Cooperative Blast Nurseries in Thailand (1962-63). P. Giatgong, N. Nahborong and T. Sitthichai, Thailand.
- /42 Chemical Control of Rice Insect Pests in Storage and a Test on Fungus Growth on Prolong Milled Rice. Kamol Kajaravech, Kovit and Sman Keeboonrueng, Thailand
- /52 Field Testing Rice Varieties for Resistance to the Brown Leaf Spot. Adul Worawisittumrong andSamaru Keeboonrueng, Thailand.

United Arab Republic

- /60 Reaction of Different Crosses and Lines of Rice Blast (*Piricularia oryzae*) in U.A.R. in 1961. T.Abdel Hak, U.A.R.
- /70 Cooperative Rice Variety Trial in U.A.R. 1962-63. M. Gad El-Hak, A. El-Azizi and S.S. Hindi, U.A.R.
- /71 Use of Irradiation in Rice Breeding. I.S. Ahmed and M.A. Masoud, U.A.R.

United States of America

- /10 Rice Gene Symobolization and Linkage Groups. U.S.A.
- /29 Cooperative FAO International Rice Commission Wide Adaptation Varietal Test - Crowley Louisiana, U.S.A.
- /30 Breeding Hoja Resistant Varieties of Rice. C.R. Adair, R.H. Johnston, H.H. Lamey and J.G. Atkins, U.S.A.

Vietnam

- /53 Survey on the Rice Varietal Reaction to Blast Resistance in Vietnam. Doan-minh-Quan, Vietnam

Vietnam (Cont'd)

IRC/RPP-64/54	Rice Variety Trials for Wide Adaptability in Vietnam. Doan-minh-Quan, Vietnam
- /55	Upland Rice Variety Improvement in Vietnam. Doan-minh-Quan, Vietnam.

Food and Agriculture Organization

- /37	Report on the Progress of Breeding and Testing Varieties with Wide Adaptability, N. Parthasarathy, FAO
- /67	International Rice Year, FAO
- /69	Plant Quarantine in Relation to Rice. Anthony Johnston, FAO
- /70	Preliminary list of insects and mites recorded on Paddy Rice. Harry G. Walker, FAO.

APPENDIX A

REPORT OF THE
JOINT MEETING OF THE THREE WORKING PARTIES
# of the
International Rice Commission

Held at
Manila, Philippines
9 March 1964

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, Italy
1964

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"Prolonged Storage of Paddy and Milled Rice in Bags and in Bulk under different Climatic Conditions"

The Joint Meeting was opened with a review paper by Tani, Harada and Chikubu describing the work of the Food Research Institute of the Ministry of Agriculture and Forestry of Japan. The authors reviewed the importance of the initial quality of the stored rice, the problem of drying, the physical and chemical changes during storage, the storage facilities required, the control of insects, fungi, rodents and other organisms, low temperature storage, and the use of radiation. The need for more research and the interchange of information among workers was emphasized.

Several other papers were presented dealing with storage conditions in the humid tropics including the influence of moisture content and the duration of storage on the milling recovery of rough rice; the effect of drying air temperature and type of storage on the viability, milling recovery and nutrient content; the control of insect pests and rodents in Southern Australia, the problems of drying and aeration of rice in Southern Australia; and the relationship between moisture content at harvest and the percentage of sun cracking to the milling yields. In Australia, much of the success in rice marketing is due to the control exercised by the Rice Marketing Board over these factors. Rigid standards are adhered to and better success in maintaining these standards will depend on the development of techniques for more accurate sampling.

Discussion and Recommendations

Studies are under way inIndia on the control of *Sitotroga cerealela* and of other storage pests through bacteria. In Australia grain storage at the high moisture content of 16.5 per cent is possible because under those climatic conditions simple ventilation lowers the moisture rapidly to the safe level of 12 to 13 per cent. Under humid conditions, 16.5 per cent moisture content at storage is dangerous. Investigations on grain drying and on factors affecting milling quality have received only minor attention. Strengthening of research on these aspects is needed.

The meeting agreed that the topic of prolonged storage of paddy and milled rice requires more time for discussion than provided for at this meeting. It recommended that adequate provision be made in the Agenda of the next meeting of the Working Parties.

"Tillage and Sowing Practices and their Effect on Yield"

The effect of implements and of sowing practices on yield varies with the climate, the time of the year and with numerous biological factors. It is advisable that each factor should be evaluated separately. For example, for tillage operations, individual tools should be compared with regard to yield and cost. Results of such comparisons should result in the selection of implements for all kinds of operations.

Two papers were presented from Australia on practices which differ from those generally followed in Asia. They dealt with sod-seeding of rice and with the use of DPA (propanil or 3,4-dichloro-propionanilide) for the control of barn-yard grass in the Murambidgee irrigation area of Australia.

Under Australian conditions, a rice crop generally follows pasture. Land preparation for rice following pasture represents a significant proportion of total production costs. The practice of sod-seeding is becoming increasingly prevalent. Rice is sown directly into the pasture sward using a machine which sows and fertilises in one operation. Extended grazing, less frequent irrigation, less weed infestation, together with reduced costs, are advantages of this technique. Success depends on thorough grading of the field during the pasture establishment phase, good drainage and the timely grazing of pasture up to rice emergence.

Despite careful land preparation, successive flooding and drainage creates ideal conditions for the development of the barn-yard grass. Supplementing various cultural and mechanical methods of control, the use of the herbicide DPA has contributed to increasing yields considerably.

Discussion and Recommendations

A great deal of work has been done in the USA on the control of weeds by chemicals. The results of this work may be presented at the next meeting of the Working Parties.

"Rice Physiology with Special Reference to Nutrient Metabolism"

The Mineral Nutrition of the Rice Plant. This topic was the subject of a special Symposium organised from February 23 to 28 1964 by the International Rice Research Institute, Los Banos, Philippines. The Symposium was attended by 27 participants and 55 observers from 17 countries. The salient features of the discussions may be summarized as follows:

Rice roots possess oxidative power and take up nutrients when the rhizosphere is oxidised. The oxidative power is highest during the tillering stage. The most favourable metabolic pathway of oxygen secretion of the rice plant is the "glycolic acid pathway". Nutrient uptake may be inhibited by H_2S and organic acids such as butyric acid, through action on the enzymes of aerobic respiration. Conversely, the uptake may be enhanced if small quantities of enzyme promoters are mixed with fertilizers.

Nitrogen shows two peak periods of absorption. Phosphorus absorbed before flowering is the main source of supply to the grain, while calcium is absorbed during the ripening stage. Absorption of potassium is high at transplanting and again after flowering until complete ripening. It has been observed that in soils with a low phosphorus content, nucleic acid materials, in concentrations as low as one hundredth of the phosphorus concentration, have a remarkable growth-promoting effect.

In Japan, iron and manganese deficiencies on rice have been observed in some soils. It is presumed that the other micro-elements are supplied from compost and irrigation water. Silicon appears to be important for rice culture, as fifty per cent of rice lands in Japan require the application of silicates for normal rice growth.

Most of the so-called "physiological diseases" of rice are aggravated by reducing conditions in the soils. These result in the liberation of toxic substances like H_2S formic, acetic, and butyric acids, and ferrous iron. In acid soils aluminum toxicity occurs. Drainage, application of red hill soil, lime, P and K fertilizers, etc., and growing resistant rice varieties remedy the situation. Fresh organic matter or sulphate fertilizers should not be applied.

The pattern of nutrient uptake varies considerably with climate, soil, variety, cultivation methods and amounts of nutrients applied. Detailed knowledge of the factors is essential for obtaining high yields through the timely application of nutrients. International co-operative research in this field is strongly recommended. In Japan, it was found that rice requires easily available nitrogen during six specific periods of its growth: (1) basal application, (2) at the most active tillering stage, (3) at the neck-node differentiation stage, (4) at the initial stage of spikelet differentiation, (5) just before the reduction division stage, and (6) just after heading. Phosphorus, however, can be applied as a basal dressing for satisfactory results. Attempts have been made to determine the times when the plant needs top-dressing, by analysing the different parts of the plant during different periods of its growth, but such efforts have met with only limited success.

Natural supply of nutrients from the weathering of soils, irrigation water, organic manures, rain, and N-fixation by micro-organisms play a very important part in the nutrition of plants. There is a tendency to overlook the magnitude of these natural supplies and to use too much fertilizers. In submerged paddy soils, the natural supply of nutrients is further augmented by the increased solubility of phosphate, silica, manganese, iron and by the displacement of cations in the soil solution, but the rates and magnitudes of these changes vary widely from soil to soil. Submergence, however, produces certain toxic substances as mentioned before. Therefore, in order to make use of the higher availability of the nutrients and to avoid the toxicity due to organic materials, poorly drained soils containing high organic matter, should be flooded 4 to 6 weeks before planting.

Field Experiments. Evaluation of the effect of soil, climate and water management on yield requires many field experiments. Unfortunately, however, few experiment stations are in a position to carry out the required number. This difficulty was overcome in India by initiating, in 1943, randomly scattered simple fertilizer trials in cultivators' fields. Through the efforts of FAO since 1951 this technique is now applied with satisfactory results in 19 countries in Asia, Far East, Near East, Africa and Latin America.

Nitrogen absorption in Rice Root. Nitrogen absorption in relation to age of root, stage of growth, portion of the root and to various environmental factors such as oxygen shortage, temperature and light intensity, is reviewed in a paper from Japan.

The rate of nitrogen absorption is very high in young roots but decreases as they become older. This is closely related to the change of respiratory rate of roots. A rice plant growing in the field develops more than 600 roots per hill. Formation of new roots is linked to the formation of new tillers. Nitrogen absorption depends upon the number of young roots. Hydrogen sulphide and organic acids such as formic, butyric, and propionic acid inhibit the aerobic respiration of root and retard nitrogen absorption. Shortage of oxygen supply and high or low temperatures also influence nitrogen absorption. The rate of root respiration is retarded by the shortage of substrate supply, when the cause of the shortage is due to restricted light intensity or heavy application of nitrogen.

Nutrient absorption by the root is brought about through utilization of the energy evolved through aerobic respiration in the root. This respiration depends on (1) the activity of respiratory enzymes, (2) supply of oxygen, and (3) supply of substrate. In general the respiratory enzymes govern the relationship between nitrogen absorption and age of root, stage of growth, hydrogen sulphide, organic acids and temperature. The aerobic respiration system affects the oxygen supply and nitrogen absorption is governed by substrate supply to the aerobic respiration.

"Water Management in the Course of Crop Development in Rice"

With the need for more rice, many of the rice growing countries of South-East Asia are developing their irrigation resources to supplement the rainfall. Good water management must take into account not only the critical stages of plant requirements but also such important factors as soil fertility and structure. water depth and irrigation intervals, and environmental factors such as temperature and day-length in relation to plant growth and field operations.

In Asia rice growers use much more water to produce the same weight of rice than growers in the U.S.A. The following figures are given by Dr. J.R.A. McMillan of Australia in a recent report on water economy in crop and animal production:

Country	Kg. of water per kg. of rice
U.S.A.	3300
Japan	4900
Thailand	10000
India	10000

A contribution from Japan, "Some Problems in Agronomy of Irrigation and Drainage" summarises the results of investigations as follows:

1. Agronomical significance of submerging irrigation

The submerged state is most desirable for rice growth and yield. Submerging irrigation, using large amount of river water, can supply various nutrient elements to the paddy field, although the kind and quantity of them varies with the quality of river water. Moreover, submerging irrigation increases the availability of soil nutrients and suppresses weed emergence. However, submerged irrigation favours soil reduction with its many adverse effects to the root system. This is a reason for the necessity of appropriate drainage and percolation of water.

2. Effects of Water Shortage at Different Growth Stages on Rice Yield

The stages after panicle primordium initiation require a great deal of water, shortage of which causes serious yield decreases. Water shortage at the rooting stage results in poor stands and consequently in decreased yields. Water shortage at the end of the vegetative stage favours yield increases; this is the stage when the mid-summer drainage is practised.

Based on these results, a water-saving irrigation method and a drought damage preventing method have been devised in southern Japan where there is shortage of water.

3. Mid-summer Drainage

This is one of the most popular practices in Japan. Advantages of this practice are: (i) maintenance of physiological activity of rice root, (ii) removal of excess nitrogen and (iii) prevention of lodging. Yield increasing can readily be brought about in fertile soils with heavy application of fertilizers, while in less fertile fields with a shallow top soil layer, the practice is apt to decrease yield.

4. Water Percolation

The role of water percolation is to remove toxic products and give favourable environment to roots. However, a high rate of percolation causes leaching of plant nutrients. In the ill-drained paddy field with abundant production of toxic substances in the soil, the percolation exerts a beneficial effect on rice growth and yield; this is not true in the well-drained field.

5. Control of Soil Temperature by Irrigation

In southern Japan, the continuous flow of irrigation water prevents the increase of the water temperature and results in higher yields than in the usual submerging irrigation in which the water is left to stand.

In experiments conducted during 1963 at the Central Rice Research Institute, rainfall of 50.7 inches (1287 mm) during rice growth was quite sufficient and extra irrigation did not increase yields.

Discussion and Recommendations

The figures given for the amount of water used for rice in different countries might be misleading. These are averages, and the figures on yield per acre and the significance of the uncontrolled surplus water have been ignored.

Full documentation on this important subject was needed, especially on the quality and solid matter content of irrigation waters and on the amount of water required under different climatic conditions; also information is needed on the legislative aspects of water use. It would be useful if FAO could compile this information.

There was some discussion on the question of intermittent irrigation and its effect on nitrogen loss on soils of certain textures and on the production of toxic substances in the soil. It was agreed that these have only been found in small quantities but that under certain conditions they might have an adverse effect on the rice plant. More information on this was needed on the evapo-transpiration rates in different climates. Under upland conditions, particularly high manganese concentration and nitrate nitrogen were found in rice plants and these might have an effect on the plant hormone system.

The Joint Working Parties considering the importance of water requirements for rice recommended that the Member Nations submit reports to the next Joint Session of the Working Parties on Rice Soils, Water and Fertilizer practices and on Rice Production and Protection on the following subjects:

1. Experiments on water requirements for wetland and upland rice.

2. The qualities of irrigation water from water courses or from the groundwater wells in respect of (a) the chemical composition and (b) the solid element content not only with respect to their origin but also as it is received in the rice fields (turbidity measurements).

It was further recommended that studies be undertaken to compare water requirements actually observed and as determined by calculation of evapo-transpiration formulae, taking into account percolation rates in the soil and loss by seepage in the irrigation canals.

"Variety-fertilizer Interaction"

The claim that japonica varieties were strikingly superior to indicas in fertilizer response provided the basis of the japonica-indica hybridization project sponsored by the I.R.C.. It was felt even at the time of initiation of this project that indicas may still possess reserves of fertilizer response that may have survived selection, and that these may be profitably exploited in breeding programs. The I.R.C. accordingly initiated simultaneously with the japonica-indica hybridization project, an investigation of variety-fertilizer interactions within the indica group; this investigation revealed that establishment of high responsive selections within the indica crosses could be obtained, and some of these are actually now in extensive cultivation. Particular mention is made of BPI 76 in the Philippines and H.4 in Ceylon.

The ultimate assessment of fertilizer response must be based on field tests, but it is essential that breeders possess a set of readily recognisable morphological traits that permit identification of high response genotypes. The association of fertilizer response with efficient exploitation of incident light provides a clue to desirable plant types that breeders must select; short strong straw, moderate tillering and thick erect narrow leaves ensure maximum light utilization and in consequence high fertilizer response.

Two papers, one from the Philippines and the other from India, attempted the evaluation of variety-fertilizer interactions. The Philippino work relates to test for fertilizer response in 36 lodging resistant lines at nitrogen levels of 120 kg/ha. These varieties mature within 120-150 days. No significant variety-fertilizer interaction was noted. However, in a subsequent study using 3 varieties significant variety nitrogen interaction was observed. In India, over a period of three years trials with a number of short and medium maturing varieties have revealed striking fertilizer response of the japonica-indica hybrid JI.431. Yields increased with up to 88 kg/ha. of nitrogen level from 624 to 1186 kg/ha. Variety-fertilizer interaction reached statistical significance in the 1961 and 1962 experiments.

Significant interaction with varieties was also demonstrated in potted rice experiments with respect to the number of effective tillers, weight of a thousand grains and number of filled grains.

No significant response of later maturing varieties to fertilizers was demonstrable in field tests in 1962 and 1963, although the main effect of varieties and nitrogen assumed significance. This work in India supports the argument that search for fertilizer response should be restricted to early maturing varieties.

Discussion and Recommendations

As regards the value of pot experiments for appraising variety-fertilizer response, it was pointed out that the light factor in such experiments is different from that in the field. It was agreed that field conditions were not duplicated in pot experiments, but that pot cultures could be useful for evaluating potential response. Population studies and single plant studies should both be carried out.

"The Proposed International Rice Year"

This subject, which was also included on the Agenda of the individual Working Parties, was introduced by Dr. R.W. Schickele, Director, Division of Land and Water Development, FAO, Rome.

Dr. Schickele suggested that the proposed International Rice Year offered a challenge to the Working Parties to meet the urgent need to increase rice production. The major lines of activity were: a) more effective use of fertilizers, pesticides and other crop protection measures; b) better land-use and water management practices; c) improvements in methods of production, storage, processing and loss prevention, and in the use of rice by-products.

An International Rice Year would stimulate attention and support by national authorities for needed rice improvement programs.

He invited technical authorities to consider in quite specific terms just how scientific knowledge could be put into general farm practice. Technical men have the opportunity to offer specific suggestions where government attention is needed and what action is required to motivate farmers to employ improved practices. Seed distribution policies, credit facilities and marketing arrangements hold real possibilities to provide the incentives toward greater production. Demonstrations at the farm level, pilot schemes in selected areas and other extension methods can be effective in bridging the gap between research and practice.

Dr. Schickele then outlined a number of activities and projects in which FAO could engage in order to assist Member Countries in putting their own programs into operation. He also referred to the Expanded Program of Technical Assistance, the UN Special Fund and Freedom-from-Hunger Campaign as sources of possible assistance by which FAO could actively engage in helping Member Countries to carry on their development plans.

The Joint Meeting recommended:

(i) That the International Rice Commission take appropriate action to have prepared a comprehensive review of the activities of its Working Parties for the purpose of directing the attention of Member Governments to the nature of completed projects and accomplishments to date. Such a review should also note projects currently in progress and should report possible activity programs for the immediate future.

(ii) That technical personnel should give immediate careful consideration to practical measures that should and could be taken in their respective countries to assist and encourage solutions of problems relating to rice. Suggestions, proposals or plans in this regard should be directed through their governments to the IRC as well as to the Director-General of FAO.

TIME AND PLACE OF NEXT MEETINGS

Although delegations were not prepared to make commitments concerning the place of the next meetings, they urged that:

(i) The three Working Parties meet in one country; meet consecutively and not simultaneously; and, if possible, more time be provided for the sessions.

(ii) The time and place of the next meetings be determined as soon as possible to permit adequate programming and paper preparation. It was noted that it would be most advantageous if the meetings could be held at the time when the local rice crop is in head.

(iii) Arrangements be made to have a greater number of "invitation papers" prepared for the occasion.